

**A SIMPLE EXPLANATION OF WHY TIME STOPS  
AT THE SPEED OF LIGHT**

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**Abstract**

According to Einstein's theory of special relativity, the elapsed time for two observers with different speeds in an inertial frame of reference will be measured unequally. The faster the speed of observer, the slower the passage of time. This paper explains why time stops at the speed of light in an understandable manner.

**Keywords:** Relativity, Elapsed time, Observer

## 1. Introduction

What is time? There are maybe many definitions for time that are all correct but in order to have a fair judgment, the historical process of time must be considered.

Until a few hundred years ago, it was thought that the earth is the center of the universe and the sun is rotating around it [1]. Imagine a situation where the sun is in the middle of the sky. After a while, the sun moves a little and this movement continues until it reaches the corner of the sky and night falls. The next day, after sunrise, the sun begins to move and will be transferred to the middle of the sky (we look at this matter from the point of view of those who defined time hundreds of years ago). From this issue it can be concluded that the best definition of time is a relative motion between two objects. So, if it is assumed that the earth is the origin of the universe just like olden days, the movement of the sun around it is called the passage of time.

## 2. The true perception of time

The interval between two consecutive observation of the sun in the middle of the sky is divided into 24 equal parts and each part is named an hour. Similarly, we divide every hour into 60 equal parts and call them minutes and every minute into 60 parts and call them seconds. We invented the clock that simple!

Now, consider a person wearing a watch in the northern hemisphere during summer and looking at the sky while the sun is in the middle of it. In this case, his watch shows 12 noon (Suppose it is always 12 o'clock when the sun is in the middle of the sky). He decides to travel clockwise on the earth at the same speed and direction of the sun (Fig.1).

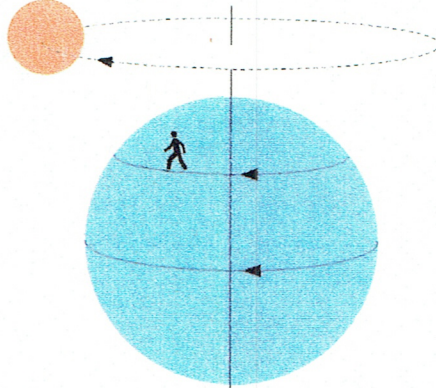


Fig.1. A person moving clockwise on the earth and parallel to the equator

One hour later, his watch shows 1 pm. When he looks at the sky, the sun is exactly in the middle of it, so he must set the watch back an hour. This person keeps moving and it is always 12 noon for him, whereas if he had remained in his original place,



he would have perceived morning, noon, evening and night. This person is so pleased that he has managed to stop time. He keeps to the path consistently and passes the original place many times. After a few months of movement, he notices the change of season and asks himself that I have stopped time and it is always 12 noon, so why is the season changing and transiting from summer to autumn?

After a while of reflection, he decides to deflect his way and incline to the south at a tiny angle of less than 0.5 degrees with respect to the equator. In this case, for instance, if his original place is Helsinki (Finland), the next day he will arrive in Tallinn (Estonia) instead of Helsinki, in Bucharest (Romania) after one month and finally in Cape Town (South Africa) after 6 months (Fig.2).

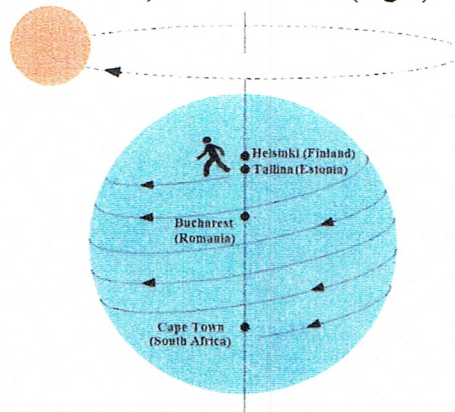


Fig.2. A person moving clockwise on the earth at a tiny angle to south with respect to the equator

Afterwards, he deviates from his path less than 0.5 degrees to the north and will reach the original place in 6 months (Fig.3).

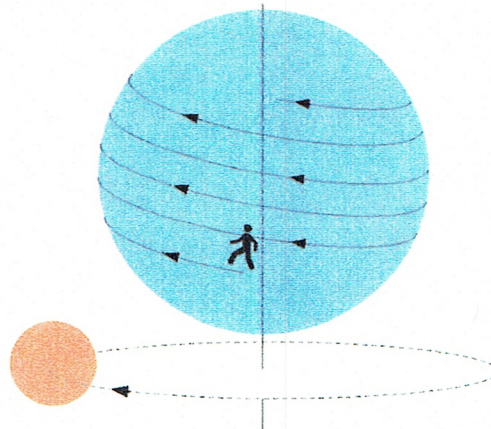


Fig.3. A person moving clockwise on the earth at a tiny angle to north with respect to the equator

At this time, he is pleased again that he has managed to stop time because it is always summer and 12 noon for him. If he had remained in the original place, he would have perceived nights, days, summers, winters and different hours but now, time has stopped for him and it is 12 noon in summer. After a few years of motion, this person feels that he is growing old and asks himself again: if time has stopped for me, so why is my hair turning white?

He is absorbed in thought again and after a while, the question arises in his mind is that he may have chosen the origin and the velocity incorrectly at first.

The human body is made up of cells. A cell is constituted of molecules and a molecule is formed by atoms. The atom, in turn, is composed of nucleus with electrons rotating around it in different directions. On the other hand, the highest speed in the universe belongs to light which is exactly equal to 299,792,458 (m/s) in a vacuum.

Assume that the universe is traveling at the speed of light in all directions relative to an unknown origin. In this case, if a person travels in an arbitrary direction at the speed of light, his relative velocity equals zero with respect to the motion of the universe and time will stop for him in the full sense of the word. To put it another way, since a person traveling at the speed and direction of sun will not observe night, then if he moves at the speed of universe he will not perceive aging.

According to the special relativity, the time interval measured by person A who is moving with constant speed of  $v$  relative to person B is given as [2]:

$$\Delta t' = \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} \rightarrow \Delta t = \Delta t' \sqrt{1 - \frac{v^2}{c^2}}$$

where  $\Delta t$  is the time period for person A,  $\Delta t'$  is the time period for person B and  $C$  is the speed of light. So if  $v = c$  then  $\Delta t = 0$  which means the elapsed time will be zero for person A.

### 3. Conclusion

The most accurate definition of time is a relative motion with respect to the universe and since the universe is moving at the speed of light in all directions, so if someone travels at the speed of light in an arbitrary direction, time will stop for him. Suppose that the universe is a moving bus which is traveling at a speed of 100 (km/h). For an observer stationary on the ground, the bus passes him and over time, will be getting further and further away, but for the one riding in the moving bus there will be no distance between the bus and him and there will be no passage of time!



### References

- [1] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962.
- [2] D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 10th ed. (John Wiley & Sons Inc, New York, 2014), Vol. 2, p. 1122.